AP Chemistry - Chemical Kinetics

Name: ______________________________ Date: ______________ Period: _____

1. After five half-life periods for a first order reaction, what fraction of reactant remains?

2. If you plot 1/[reactant] versus time and observe a straight line, what is the order of the reaction? If ln[reactant] is plotted versus time, and a straight line of negative slope is observed, what is the order of the reaction?

3. Indicate whether each of the following statements is true or false. Change the wording of each false statement to make it true.
   a. In stepwise reactions the rate-determining step is the slow one.
   b. It is possible to change the rate constant for a reaction by changing the temperature.
   c. As a first order reaction proceeds at a constant temperature, the rate remains constant.
   d. The rate constant for a reaction is independent of reactant concentrations.

4. For each reaction below give the relative rates of formation of products and disappearance of reactants using coefficients and rate change symbols.
   a. $2O_{3(g)} \rightarrow 3O_{2(g)}$
   b. $2HOF_{(g)} \rightarrow 2HF_{(g)} + O_{2(g)}$
   c. $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

5. The reaction $CO_{(g)} + NO_{2(g)} \rightarrow CO2_{(g)} + NO_{(g)}$ is second order in NO_2 and zero order in CO at temperatures less than 500K.
   a. Write the rate law for the reaction.
   b. How will the reaction rate change if the NO_2 concentration is halved?

6. For a reaction of the type A + B → C, it is experimentally observed that doubling the concentration of B causes the reaction rate to be increased fourfold, but doubling the concentration of A has no effect on the rate. Determine the initial rate equation.

7. A study of the reaction 2A + B → C + D gave the following results:

Exprmnt.	Init Con (M)		Init Rate (M/s)
	$[A]_o$	$[B]_o$	
1.	0.10	0.05	6.0×10^{-3}
2.	0.20	0.05	1.2×10^{-2}
3.	0.30	0.05	1.8×10^{-2}
4.	0.20	0.15	1.1×10^{-1}

   a. What is the rate law for this reaction?
   b. What is the overall order of the reaction?
   c. Could this reaction occur in a single step?

8. The decomposition of N_2O_5 (to give NO_2 and O_2) follows the rate law "rate = $k[N_2O_5]$" where k is 5.0×10^{-4} per second at a particular temperature.
   a. What is the half-life of this reaction?
   b. How long does it take for the N_2O_5 concentration to drop to one tenth of its original value?

9. Although hypochlorous acid, HOCl, was one of the first compounds known of chlorine, the fluorine analog, HOF, was only recently isolated. Instability is its most prominent chemical property, and it decomposes by a first order reaction to HF and O_2 with a half-life of only 30. minutes at room temperature. $HOF_{(g)} \rightarrow HF_{(g)} + \frac{1}{2} O_{2(g)}$. If the partial pressure of HOF in a 1.0-L flask is initially 100. mmHg at 25°C, what is the total pressure in the flask and the partial pressure of HOF after 30. minutes? After 45 minutes?

10. For the hypothetical reaction A + B → C + D, the activation energy is 32 kJ/mol. For the reverse reaction (C + D → A + B), the activation energy is 58 kJ/mol. If the reaction A + B → C + D exothermic or endothermic?

11. Calculate the activation energy (E_a) for the reaction $N_2O_{5(g)} \rightarrow 2NO_{2(g)} + \frac{1}{2} O_{2(g)}$, from the observed rate constants at the following two temperatures: (a) at 25°C, $k = 3.46\times10^{-5} s^{-1}$ and (b) at 55°C, $k = 1.5\times10^{-3} s^{-1}$.

12. For a certain reaction, the constant A in the Arrhenius equation is 6.00×10^{12} mol/Ls and E_a = 100. kJ/mol. What is the rate constant at 400. K?

13. The ozone layer in the earth's upper atmosphere is important in shielding the earth from very harmful ultraviolet radiation. The ozone, O_3, decomposes according to the equation
$2O_{3(g)} \rightarrow 3O_{2(g)}$
The mechanism of the reaction is thought to proceed through an initial fast equilibrium and a slow second step.
Step 1. Fast, equilibrium $O_{3(g)} \leftrightarrow O_{2(g)} + O_{(g)}$
Step 2. Slow $O_{3(g)} + O_{(g)} \rightarrow 2O_{2(g)}$
    a. Which of the steps is the rate-determining step?
    b. Write the rate law for the rate-determining step.
    c. What is the molecularity of each step?

14. Assume that an A molecule reacts with two B molecules in a one-step process to give AB_2. That is, $A + 2B \rightarrow AB_2$
    a. Write the rate law for this reaction.
    b. If the initial rate of appearance of AB_2 is 2.0×10^{-5} mol/Ls when the initial concentrations of A and B are 0.30M, calculate the rate constant for the reaction.

15. The mechanisms below have been proposed for the following reaction:
$2H_{2(g)} + 2NO_{(g)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$
The experimental rate law is "rate of appearance of $N_2 = k[NO]^2[H_2]$." For each mechanism, indicate whether or not it is consistent with the observed rate law.

Mechanism 1: $H_2 + NO \rightarrow H_2O + N$ (slow)
$N + NO \rightarrow N_2 + O$ (fast)
$O + H_2 \rightarrow H_2O$ (fast)

Mechanism 2: $2NO \leftrightarrow N_2O_2$ (fast)
$N_2O_2 + H_2 \rightarrow H_2O + N_2O$ (slow)
$N_2O + H_2 \rightarrow N_2 + H_2O$ (fast)